

BEETRON

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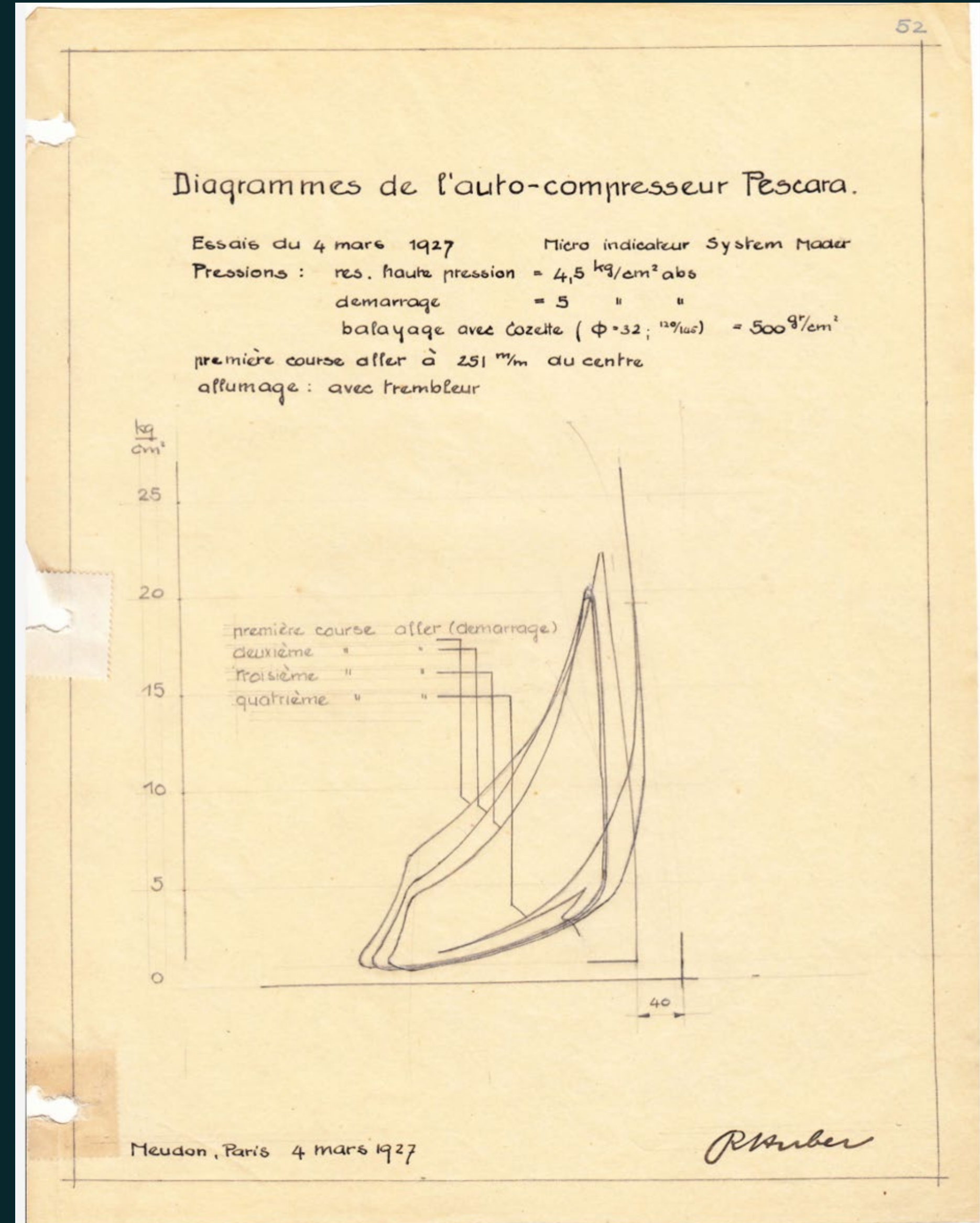
Twin Chamber - Free Piston Engine

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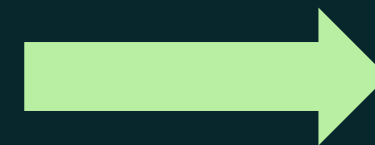
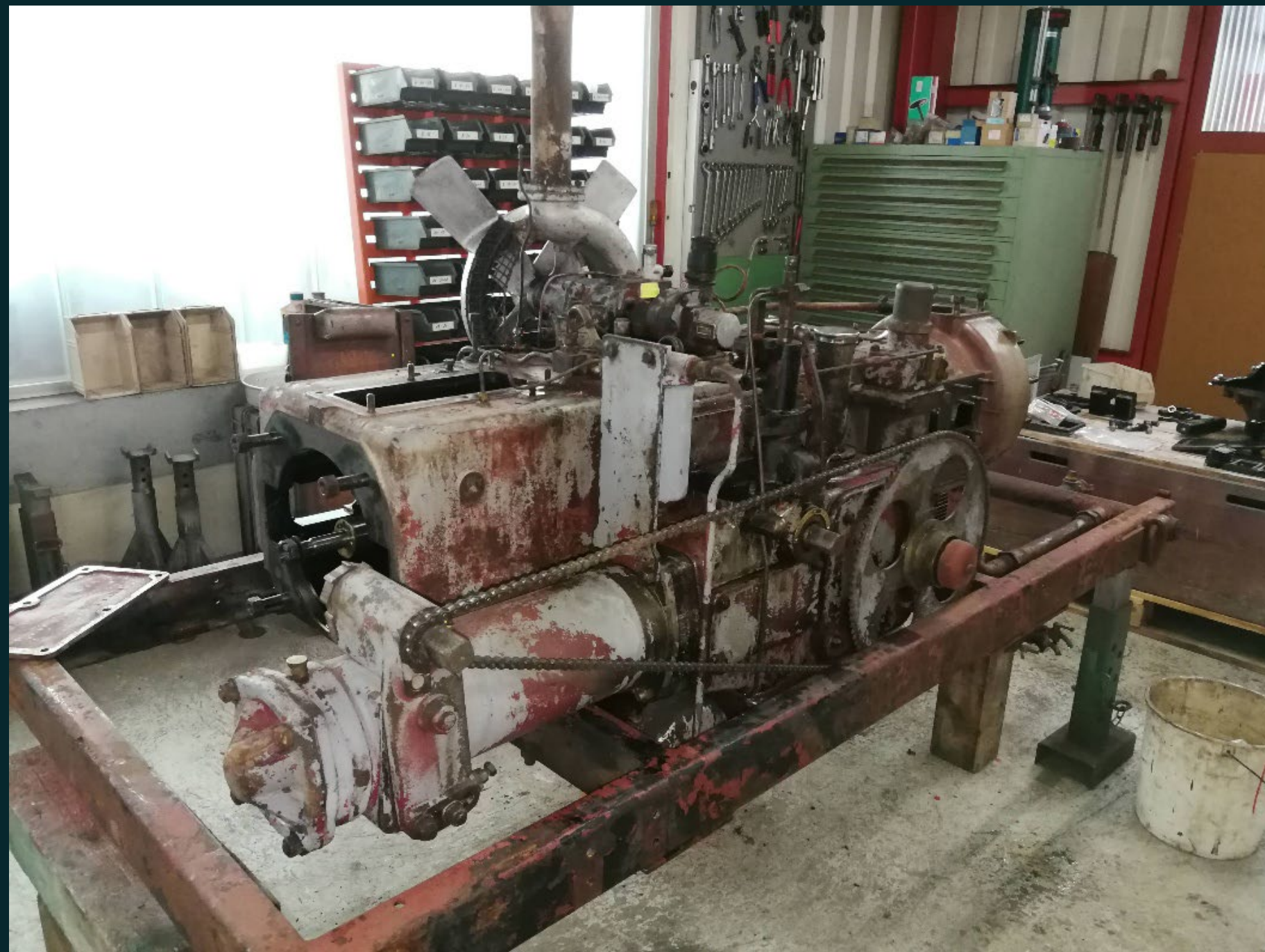


Beetron History

First run of an opposed Free Piston Engine in March 1927 by Swiss Engineer Robert Huber

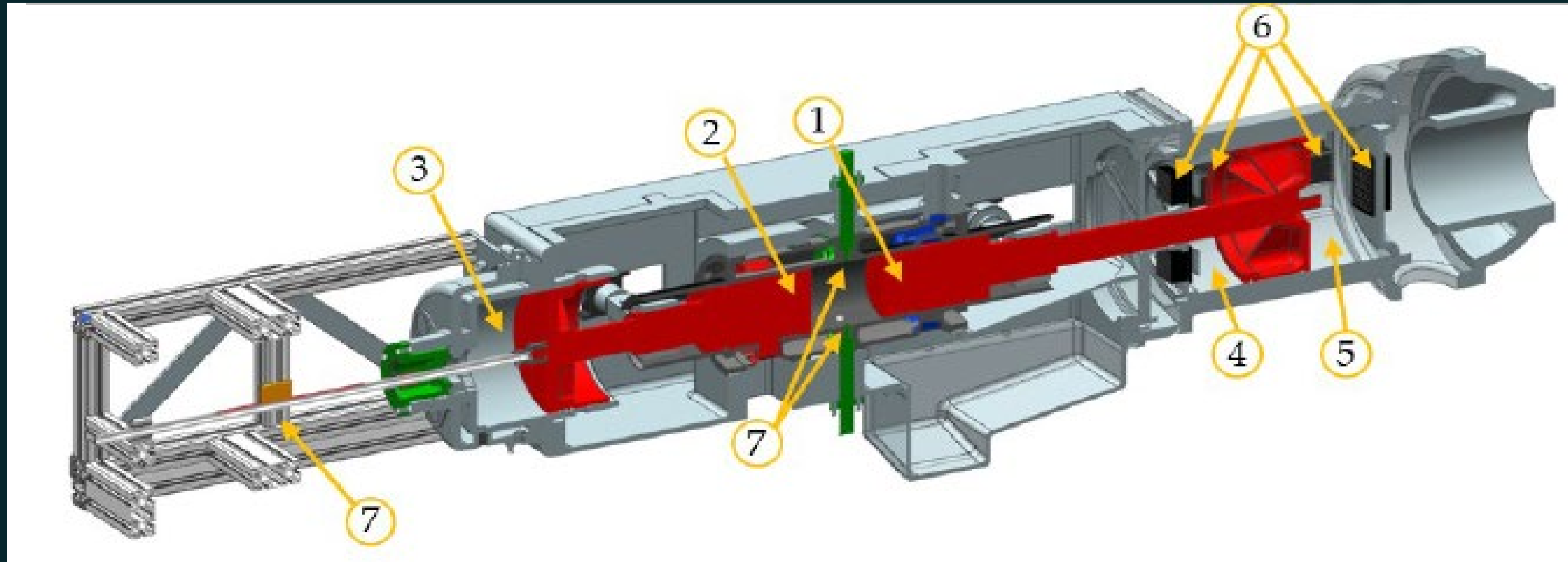


Project start with opposed piston test bench



Mesurements based on a stable running
Pescara Compressor

Measurements on Test Bench



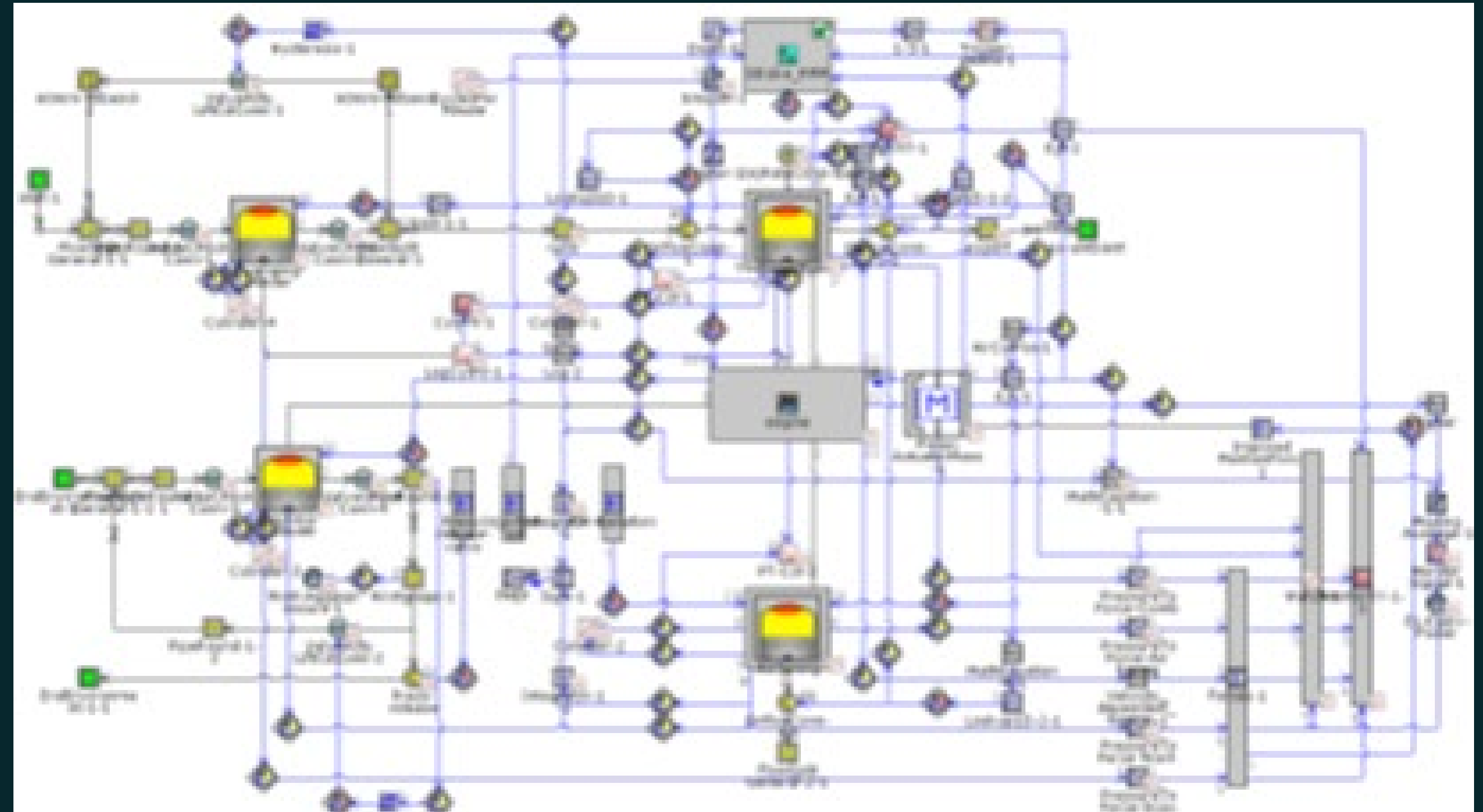
- Digitalization of FPE, creation of drawings and CAD models
- Integration of required sensors (20)
- Base for Dimensions, Volumes, Masses
- Test runs with measurements
- Thermal efficiency of 47%
- Compression ratio of 33:1

Key Specifications of Test Bench

- Displacement: 2.7 l / diesel
 - Fuel Injection: 2 injectors into reaction chamber
 - Operating Frequency: 20 Hz
 - Power Output: 24 kW
 - Stroke: approx.: 140 mm
 - Boost Pressure: 1.6 bar
 - Injectors: 2-hole fan-spray nozzles
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- Boost pressure is built up by compressor piston and check valves. A large storage chamber rated at 1.6 bar ensures sufficient purging and filling during gas exchange.

Simulation Model GT power

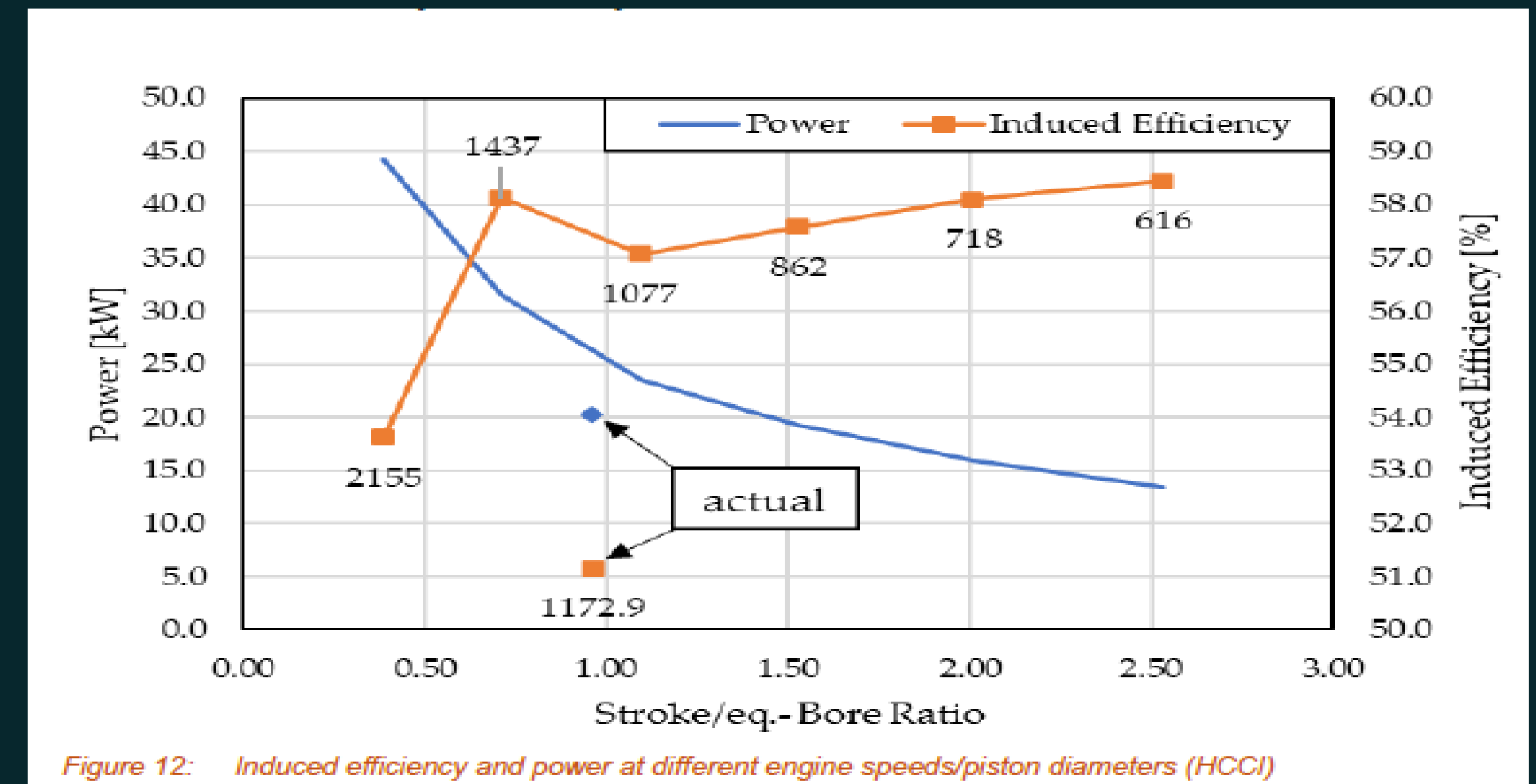
- GT-POWER Model: Development of a detailed simulation model using GT-POWER.
- Software Adaptation: Adaptation of the simulation software to account for non-sinusoidal, linear piston motion / Milestone



$$m \frac{d^2 x}{dt^2} = F_{\text{gas}} - F_{\text{generator}} - F_{\text{friction}} - F_{\text{other}}$$

Optimized FPE with GT Power

- Efficiency Optimization: Optimization of fuel conversion and gas-exchange processes to achieve > 50% fuel-to-electrical power.
- Electrical Efficiency: Generator and power electronics efficiency of >90%.



Results of simulation of optimized FPE

Piston Kinematics

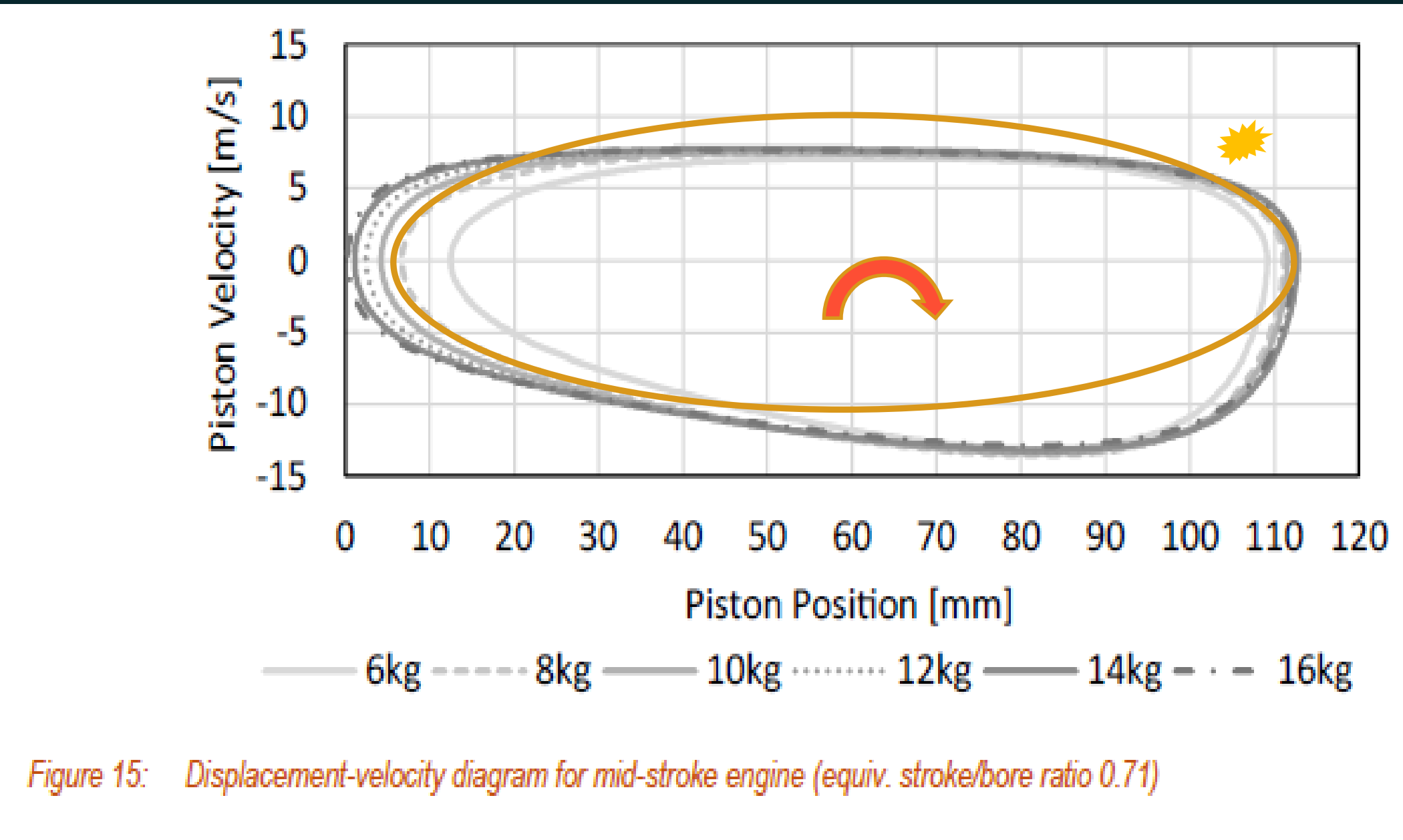
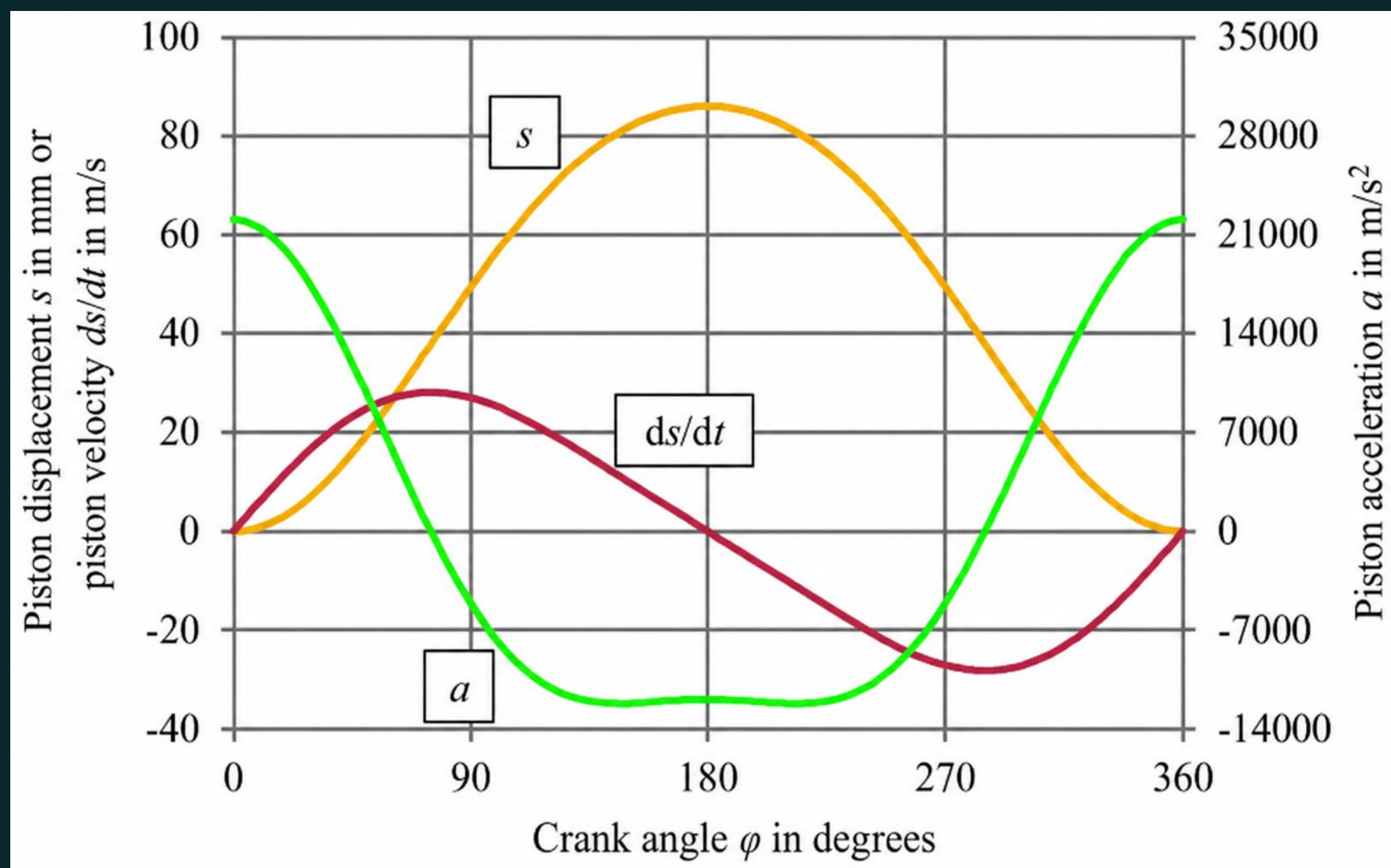


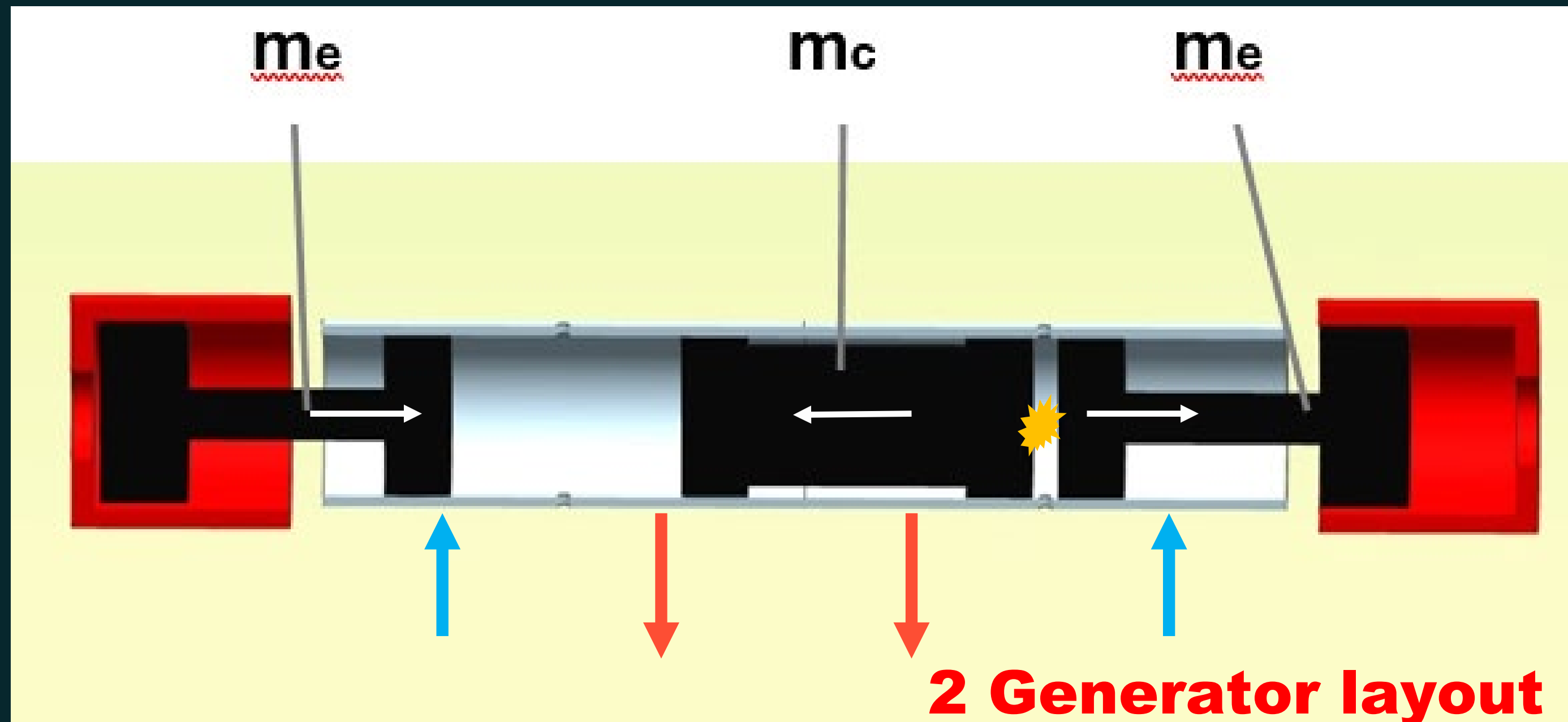
Figure 15: Displacement-velocity diagram for mid-stroke engine (equiv. stroke/bore ratio 0.71)

Crankshaft engine

Pescara Engine with gasspring



Modular design with Twin Chamber engine / Pat. pend.



$$mc = 2 \times me$$

- Double exhaust
- Double intake

- 2 x power output / «1-Stroke»
- Different possibilities to combine FPE with pumps, compressors..
- No sealing, regulation of gas spring necessary
- Open ends possible
- Position of exhaust slots depending on number of generators

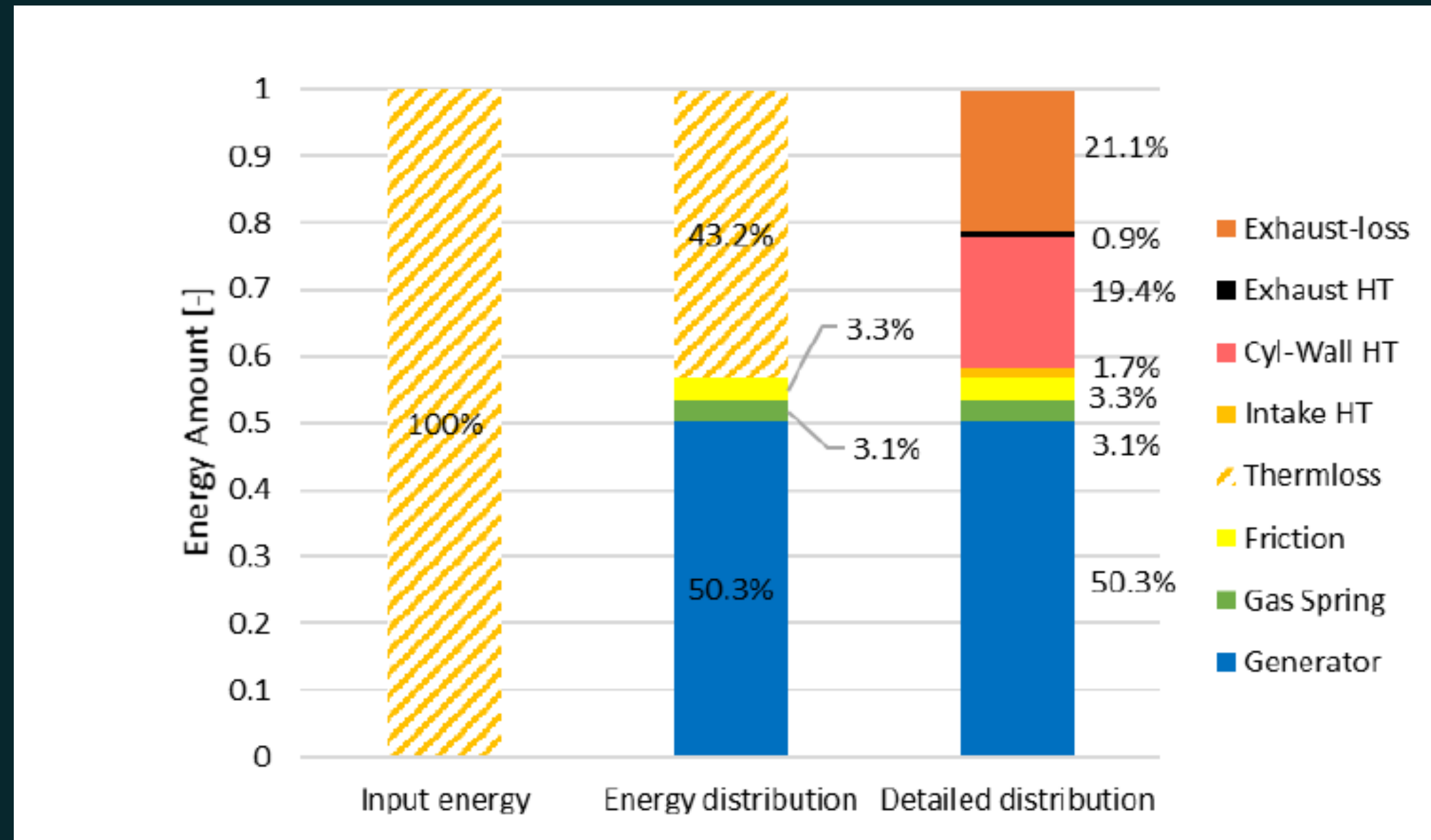
New Layout offers lot of possibilities

- Today's technologies injection strategies
- High potential for advanced concepts, RCCI / HCCI
- Potential for hydrogen operation as an alternative fuel
- Detailed thermodynamic and numerical simulations
- Quantification of efficiency potential and identification of optimal operating conditions
- Focusing on industrialization rather than on even higher efficiency



Simulation – Optimized FPE

Twin chamber / summary



Energy distribution and losses with Pescara layout

- Exhaust-driven turbocharger instead of mechanical drive
- Two-chamber exhaust gas supply for improved turbocharging
- No air spring → Higher power density
- Downsizing possibilities
- More options for cooling
- Higher el load can be extracted
- Shorter stroke / earlier induction
- Compression ratio not depending on gasspring

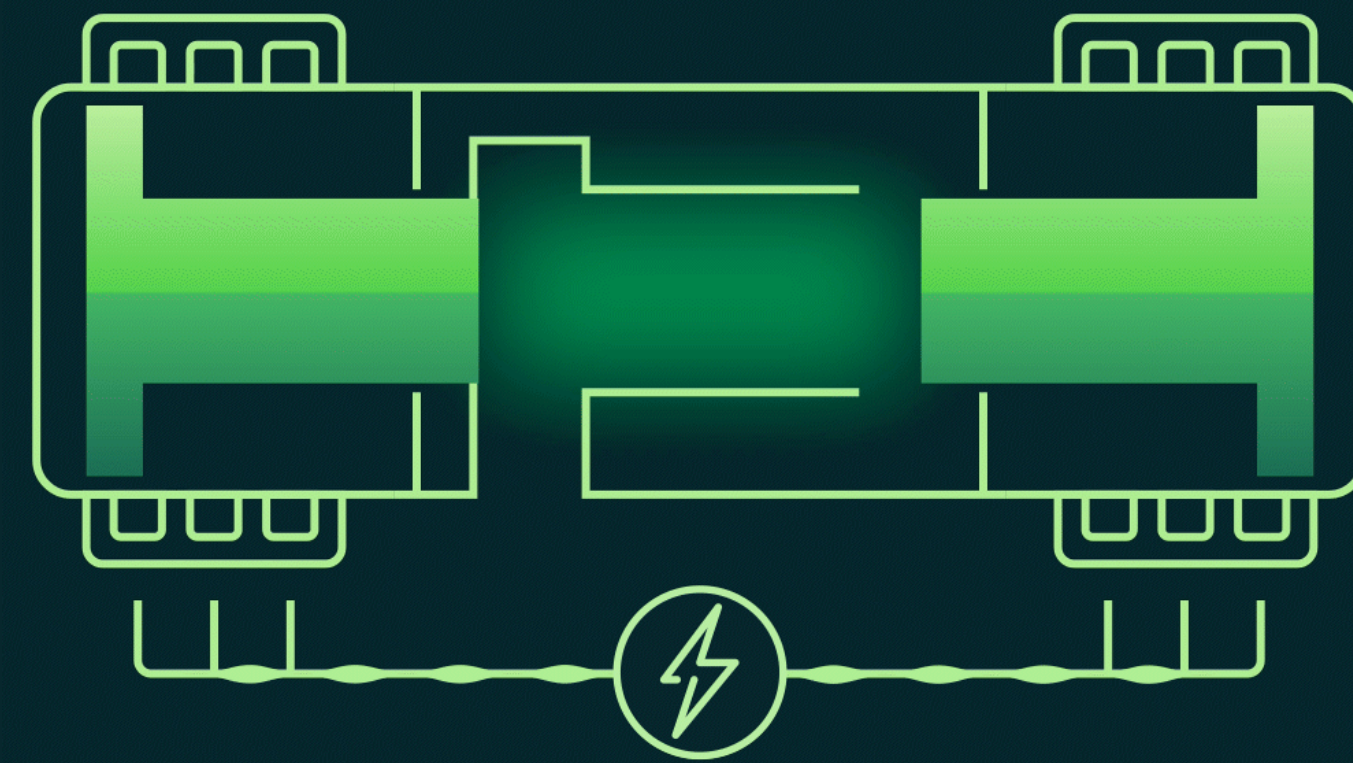
**I hope I've given you some insight into our
project and would like to**

**Thank you for your attention and for
supporting an open technology - approach
to future decarbonization!**



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HCCI (homogeneous charge compression ignition)

